

The surfaces A and C should be sensibly plane, but, as they turn with the whole optical system, exact geometrical planes are not necessary for accuracy.

The eyepiece joins on at *a*, and can be partially supported by friction-rollers with a definite weight suspended to avoid flexure. The whole turns about the pivots *a* and *b*, and should be reversible. The adjustments can all be determined as for an ordinary Transit-Circle, but reflexions near the zenith would be possible.

*Radiant Points of Shooting Stars observed at Bristol in the Years
1878 and 1879. By W. F. Denning, Esq.*

In continuation of my previous catalogues of meteor showers (*Monthly Notices*, Jan. 1877 and March 1878), I send two further lists, of 20 Radiants observed between July 21 and Aug. 10, 1878, and of 47 observed between July 28 and Nov. 14, 1879. I have selected the positions of such showers as were best observed, for in observations of this character there are always a large proportion of suspected streams from which four or five meteors only have been recorded. These have been omitted in the present case—indeed, it is necessary that uncertain positions should be invariably excluded, because they only originate complications which it is most desirable to avoid.

Towards the end of July and early in August 1878 we had a succession of very clear nights, and I recorded 621 shooting stars in 34 hours of observation. Amongst the large number of radiant points resulting from their reduction, two were of very exceptional character, and have already been referred to in the *Monthly Notices* (Jan. 1880, pp. 124–127). The following list comprises the most important streams:—

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Radiant Points observed July 21 to August 10, 1878.

Reference No.	Date.	Radiant Point α	δ	No. of J's	Notes and Comparisons.
1878.	July 31-August 1	332° + 50'	14		Lacertids. Meteors very swift and short.
2	July 27-30	341° - 13'	54		δ Aquariads. Slowish, long meteors; fine shower. = No. 59, 1877.
3	July 30-August 1	32° + 53'	63		χ Perseids. Swift meteors, with streaks; very fine shower.
4	July 31-August 1	12° + 70'	16		Meteors faint and not very swift. Heis 15° + 70°, July 28-29.
5	"	321° + 31'	10		Maximum, August 1. Very slow; near ζ Cygni.
6	August 1-2	291° + 70'	14		δ Draconids. Swift, short meteors. Heis 292° + 70°, August 3-19.
7	July 25-31 & Aug. 10	6° + 37'	23		Swift, streak-leaving meteors. = No. 49, 1877.
8	July 29-August 2	333° + 9'	10		Meteors very slow. Corder 333° + 12°, July.
9	July 21-August 1	{ 11° + 47'	26		Meteors very swift, with streaks. Radiant diffus. Probably two showers close together.
10	July 25-26	332° + 37'	11		Bright, slow meteors, with long paths. S. & Z. 336° + 30°, July 28.
11	July 26-August 1	28° + 36'	12		Very swift meteors, with streaks. S. & Z. 32° + 35°, July 30.
12	July 26-31	333° + 18'	8		Swift, faint meteors. Corder 333° + 12°, July.
13	July 26-27	354° + 42'	7		Slowish, faint. Well defined.
14	July 31-August 1	7° + 11'	9		Meteors bright and very swift, with streaks. Radiant exact.
15	July 29-August 1	23° + 41'	7		Swift, streak-leaving meteors.
16	July 20-28	18° + 59'	8		Swift, streak-leaving meteors. Corder 20° + 60°, August.
17	July 27-31	28° + 28'	7		Swift meteors.
18	July 31-August 1	65° + 60'	7		Small, faint, and slow moving.
19	H July 27-31	332° + 27'	8		Faint; very swift. S. & Z. 336° + 30°, July 28.
20	August 7-10	{ 42½° + 54'	106		Perseids. Apparently a double shower, separated 5° in declination.
		44° + 59'			

In addition to these I may mention showers at $96^{\circ} + 72^{\circ}$, $47^{\circ} + 25^{\circ}$, $31^{\circ} + 18^{\circ}$, $30^{\circ} - 15^{\circ}$, $50^{\circ} + 75^{\circ}$, $33^{\circ} - 20^{\circ}$, $134^{\circ} + 78^{\circ}$, $284^{\circ} + 44^{\circ}$, $22^{\circ} + 13^{\circ}$, $33^{\circ} + 62^{\circ}$, $76^{\circ} + 54^{\circ}$, &c., as observed with less distinctness. Indeed, though I have selected only 20 centres for the above table, I saw 41 different showers during the seven nights July 26-Aug. 2; and from a careful analysis of the path directions, there were indications of at least 14 additional radiants, so that the aggregate number of meteor streams in action at this particular epoch was fully 55. It is true that the end of July is rather a special period, but the number of visible streams (chiefly remarkable for their extreme feebleness) is very large on every night of the year. During my observations I recorded the number of meteors seen each night, together with the state of sky, duration of watch, &c. The figures show an exceptional abundance of shooting stars:—

1878.	Period of Observations.	Length.	↓'s seen.	State of Sky.
July 26	10 $\frac{3}{4}$ to 13	1 $\frac{1}{2}$	27	Many clouds.
27	10 $\frac{1}{2}$	14 $\frac{1}{2}$	4	Very clear.
28	10 $\frac{1}{2}$	14 $\frac{1}{2}$	4	Haze; stars dim.
30	10 $\frac{1}{2}$	14 $\frac{1}{2}$	4	A little haze.
31	10	14 $\frac{1}{2}$	4 $\frac{1}{2}$	Very clear.
Aug. 1	9 $\frac{3}{4}$	12	2 $\frac{1}{4}$	Very clear. Cloudy after midnight.
2	10	11 $\frac{1}{2}$	1 $\frac{1}{2}$	Clear. Cloudy after 11 $\frac{1}{2}$ h.

Thus, during the period July 26 to August 2, 1878, I noted 403 shooting stars in watches extending in the aggregate over 22 hours.* This number was counted, notwithstanding the fact that, while registering the apparent paths of such as were accurately observed, many others must have escaped observation. On the nights of July 27 and 31, the horary rate for one observer, persistently looking eastwards, exceeded 30, and on the intervening nights I believe the numbers were equally large, but there was a good deal of haze which effectually obscured many of the smaller meteors. In 1879, I partially confirmed my results of the preceding year, for on July 28 in a two-hours watch between 11^h 45^m and 13^h 45^m, I counted 45 meteors, of which several belonged to the rich showers of Aquariads and Perseids seen in 1878. In 1881, July 27, I also noted a remarkable frequency of shooting stars, but, being engaged in telescopic observations, their numbers and directions were not fully recorded on that occasion.

Observations were resumed at the end of July 1879, and continued until the middle of November, when ill health necessitated a suspension of the work. 1096 shooting stars had

* These figures include 7 meteors seen in a short interval on July 29.

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been observed in 86 hours of watching. The results are grouped into five periods as follows :—

1879.		Hours of Observation.	Meteors Seen.	Radiants.
July 28–Aug. 12 ...	...	8 $\frac{1}{4}$	143	5
August 21–25 ...	...	16	225	12
September 14–25 ...	...	19	270	13
October 14–20 ...	...	24 $\frac{1}{2}$	280	11
November 12–14 ...	...	18 $\frac{1}{2}$	178	6

Only the most active radiants are mentioned. In the following table 47 positions are given, and to these 601 meteors were found to be conformable, or nearly so, to each centre. Many of these showers correspond with those observed in 1877, and I have pointed out these agreements in cases where they are very close.

The chief shower observed in 1879 was on Aug. 21–25 (No. 6), from a point at $291^{\circ} + 60^{\circ}$ ($56^{\circ} s$), near α *Draconis*. I gave a diagram of the tracks and accompanied it with a detailed account of the shower in the *Monthly Notices*, Jan. 1880, pp. 127–128; I also noted a very active stream (No. 32) in October from a point in the south of *Aries*, $31^{\circ} + 9^{\circ}$, which I have described in the same number of the *Notices*. As to the other displays, I saw 38 Perseids on Aug. 9–12 from the usual radiant north of η *Persei*, and in October the Orionids (No. 33) were well seen. On November 13 I watched the sky continuously for $11\frac{1}{2}$ hours ($5^h 30^m$ to 17^h), and counted 100 shooting stars; of these 18 were fine Leonids, nearly all of which made their apparition between $14\frac{1}{2}^h$ and $15\frac{1}{2}^h$. The apparent paths were noted with extreme care, and I found the radiant to be very sharply defined at $148^{\circ} + 23^{\circ}$ (No. 42). Two showers (Nos. 28–31 and 18–39) in *Auriga*, separated 23° in declination, were sharply defined both in September and October from the points $77^{\circ} + 57^{\circ}$ and $76^{\circ} + 33^{\circ}$, and I had seen the latter well both in October and November 1877 from the same point. The radiant immediately N. of β *Trianguli* (No. 19) in September was one of the best seen during the year; and the point of divergence is identical with one I have several times noted at the end of July and during the first half of August. I saw 25 Taurids and 19 Muscids on the nights of Nov. 12–14. They form active showers of slowish trained meteors, and are notable on account of their contemporary occurrence with the Leonids. They often supply meteors of considerable brilliancy, and will probably be frequently re-observed in future years, as two of the finest showers visible in November.

Radiant Points observed July 28 to November 14, 1879.

Reference No.	Date.	Radiant Point. α δ	No. of μ_s	Notes and Comparisons.
1879.	1879.	338°-14°	14	δ Aquariads. Slowish, long bright meteors. = Greg. 109.
1	July 28	32 + 53	9	χ Perseids or Perseids II. Swift; streaks.
2	July 28-29	30 + 37	6	Swift; streaks. A well-defined shower.
3	July 29	46 + 58	38	Perseids. Meteors very swift, with streaks.
4	August 9-12	215 + 76		Several bright meteors from a radiant here.
5	9-12	291 + 60	56	Draconids. A fine shower of bright, slowish meteors.
6	21-25	46 + 47	9	α Perseids. } = No. 63, 1877.
7	21-23	62 + 35	10	ε Perseids } Meteors, swift with streaks.
8	21-25	61 + 50	11	μ Perseids. } = No. 83, 1877.
9	21-23	319 + 30	12	Slow. At ξ Cygni. G. & H. 315° + 31°, July 4-August 22.
10	21-23	343 + 14	6	Bright, swift meteors. Sawyer 348° + 17°, August 28-September 2.
11	August 23	339-10	16	Slow, bright meteors. Aquariads. See No. 1. = No. 59, 1877.
12	21-23	70 + 66	9	Swift meteors. Radiant close to c Camelopardi.
13	August 23	350 + 47	8	Rather slow. Well defined and exact.
14	August 23	266 + 47	7	Max. August 22. Slow, trained meteors.
15	August 21-23	5 + 17	8	Slow meteors. Tupman 7° + 13°, August 18, 1869.
16	21-23	24 + 42	9	Swift, bright meteors, with streaks. At γ Andromedæ.
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18	September 14-25	76 + 32	10	Swift, with streaks. Schmidt $70^\circ + 32^\circ$, September. See No. 39.
19	15-25	30 + 36	16	Very sharply defined. Meteors not very swift. S. & Z. $28^\circ + 35^\circ$, Sept. 23.
20	14-25	99 + 43	15	Very swift, with streaks. Seen also on Oct. 15 and 20 at $105^\circ + 50^\circ$.
21	14-21	76 + 44	11	α Aurigids. Swift and short, with streaks.
22	14-25	31 + 19	14	Max. September 21, 10 λ 's. Slowish. In Aries.
23	14-25	82 + 75	8	Not swift; streaks. Radiant exact.
24	20-21	192 + 79	9	Very, very slow. $8^\circ p. \beta$ Ursae Minoris.
25	15-25	355 + 18	6	Slowish, bright meteors. G. & H. $352^\circ + 17^\circ$, August 22-October 15.
26	14-25	61 + 48	8	Slowish, bright meteors. G. & H. $352^\circ + 17^\circ$, August 22-October 15.
27	14-21	87 + 43	8	Swift, no streaks. At μ Persei.
28	14-21	76 + 56	7	β Aurigids. } Meteors, swift with streaks.
29	14-21	50 + 54	7	δ Aurigids. } Beginning of No. 31.
30	Sept. 21-Oct. 20	84 - 11	7	Rapid, no streaks. Also at $31^\circ + 52^\circ$ (5 slow λ 's).
31	October 14-20	78 + 57	12	Swift, streaks. Tupman $85^\circ - 15^\circ$, August 31, 1870.
32	14-20	31 + 9	37	δ Aurigids. Not very swift; streaks.
33	October 15 & 20	93 + 17	39	Max. October 15, 21 λ 's. An active shower of slow and generally small meteors. Cordon $32^\circ + 11^\circ$, Oct. Tupman $28^\circ + 10^\circ$, Oct. 13.
34	15 & 20	105 + 23	14	Orionids. Very swift and short, invariably leaving streaks.
				Very swift, long meteors, with streaks. Tupman $105^\circ + 24^\circ$, Oct. 12, 1869.

Notes and Comparisons.

Reference No.	Date.	Radiant Point. α δ	No. of J's
1879.	October 4-6 & 16-20	316 + 59	17
35	October 14-20	95 + 46	11
36	15 & 20	7 + 51	11
37	October 20	45 + 6	8
38	October 14-15	76 + 33	7
39	15 & 20	114 + 62	7
40	15 & 20	70 + 65	7
41	November 13	148 + 23	18
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43	November 12-13	133 + 70	8
44	November 12	62 + 21 $\frac{1}{2}$	14
45	November 13-14	58 + 21	11
46	12-14	46 + 21	19
47	12-14	80 + 24	7

Meteors quick, rather bright. = Heis, B 9, $315^\circ + 59^\circ$, Oct. 3-Nov. 13.
 Max. October 14. Meteors swift, with streaks. = No. 97, 1877.
 Max. Oct. 15. Slow and faint. Just S. of α Cassiopeiae. = No. 137, 1877.
 Meteors slow. N. of α Eridani. Tupman $44^\circ + 4^\circ$, October 14, 1869.
 Not very swift. = No. 126, 1877. Tupman $77^\circ + 30^\circ$, October 13, 1869.
 Meteors bright, very swift and streak-leaving.
 Meteors rather slow. At ϵ Camelopardi. = No. 34, 1876.
 Leonids. Meteors brilliant, with streaks. A contemporary shower seen
 at $125^\circ + 55^\circ$ (5 J's).
 Rapid meteors, without streaks.
 Showers of Taurids. Meteors brilliant, with trains of ashy
 sparks.
 Slow. } Showers of Taurids. Meteors brilliant, with trains of ashy
 sparks.
 Muscids. Max. November 13. Meteors slow, with spark-trails.
 Meteors not rapid. Beginning of Taurids II.

Ashley Down, Bristol:
 1881, Nov. 15.